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(54) **Process for obtaining a catalytic system for the polymerization of alpha-olefins in suspension, in gas phase at low and high temperature or in a mass at high pressure and high or low temperature**

(57) These catalytic systems are particularly suitable for the polymerization of  $\alpha$ -olefins containing from 2 to 20 carbon atoms, as well as for the copolymerization of ethylene with  $\alpha$ -olefins containing from 3 to 20 carbon atoms, diene and cycloalkenes.

The catalysts can be used in processes wherein the catalyst is suspended in a solvent, in processes in gas phase as well as in mass polymerization processes at high temperatures and pressures.

The catalytic system is characterized by the mixture of two components A and B. The component A (catalyst) is formed by a properly functionalized inorganic porous oxide, by organo aluminium compound and by an organometallic compound of a metal of the groups 3, 4, 5 and 6 of the periodic table. The functionalization of the inorganic oxide consists in the introduction of functional groups to be used to strongly fix the organoaluminium compound and the organometallic compound.

The component B or co-catalyst which is used for the activation of the catalyst is composed of organoaluminium compounds, perfluorinated derivatives of boron or a mixture thereof. The catalytic system prepared according to the present invention, have the advantage of strongly fixing the active components to the inorganic support, thus avoiding their migration in the polymerization medium. In this way a good control of the morphology of the distribution of the particle sizes and of the molecular weight of the obtained polymers is reached. Moreover these catalytic systems show a high activity in the polymerization reaction, high ratios between catalyst-co-catalyst being unnecessary, since polymers

with low contamination levels are obtained.

FIG. I

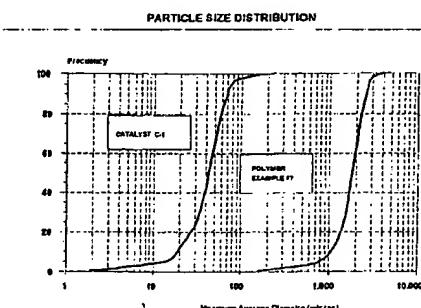
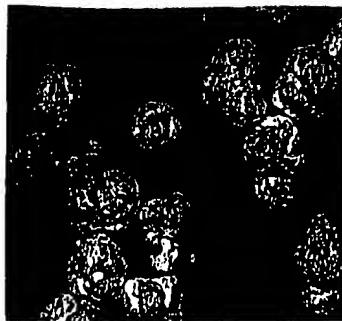


PHOTO I



**Description**

The metallocene catalysts in combination with aluminium alkyls are scarcely active for the polymerization of olefins (US 282 7446). The controlled addition of small quantities of water to the polymerization medium remarkably increases 5 the activity, thus obtaining, sometimes, activities which are greatly higher than the ones obtained by using the known catalysts Ziegler -Natta (Makrom. Chem. 179, 2553 (1978) and 169, 163 (1973), DE 1022382, US 3184416, US 3440237). The controlled hydrolysis of alkyl aluminium leads to the obtainment of the corresponding aluminoxanes. When these aluminoxanes are used as activators of metallocene catalysts a very active catalytic system for the polymerization of olefins is obtained, particularly with zirconocene catalysts (US 4542199).

10 On the other hand, it was found out (EP 277004 and EP 426637) that the use of bulky boron compounds as co-catalysts enables high activities in the polymerization of  $\alpha$ -olefins too. The co-catalysts act by forming and stabilizing the active cations by means of non-coordinative anions, without preventing the incorporation of olefin during polymerization.

15 These catalytic systems are homogeneous catalysts soluble in the known solvents used in the polymerization of olefins and form very small polymer particles (< 100  $\mu\text{m}$ ). Therefore, when these systems are used in gas phase or in suspension, a fouling or blocking of the reaction systems often takes place, thus forcing the stopping of the polymerization plant, causing a loss in the production.

20 For these reasons, it is suitable to develop the heterogeneous catalysts which are able to keep the catalytic activity of the homogeneous systems and to control the dimensions and the morphology of the resulting polymer for the obtainment of particles greater than 100  $\mu\text{m}$  and a high density of particles in the reactor (apparent density).

Works concerning the development of these catalytic solids have been carried out for many years. In general, the more used methods consist in the heterogeneization of the co-catalyst, the heterogeneization of the metallocene compound or in the heterogeneization of both components on an appropriate support.

25 The patent WO 91/09882 discloses the preparation of a supported catalytic system useful for the polymerization of olefins in suspension or in gas phase, which is formed by a homogeneous metallocene compound and an ionic non-coordinative co-catalyst of boron supported on an inorganic porous oxide. The support and the co-catalyst are physically joined, this fact can cause the migration to the reaction medium of the co-catalyst, thus obtaining products with a low apparent density and with a wide distribution of particle sizes. Moreover, the catalytic activity is very small. In a later 30 patent (WO-93/11172) a method of heterogeneization of said type of co-catalysts consisting in the functionalization of the boron co-catalyst by means of two methods is disclosed. In one of them, the functionalization takes place with groups able to react with the free hydroxyl-groups of an inorganic support and, in the other method, functional groups are introduced in order to enable the later polymerization of the boron compound, creating an insoluble polymer in the reaction medium. Even though the chemical anchorage of the co-catalyst assures that the active centers do not migrate in the reaction medium, these methods are chemically and economically expensive.

35 The patent EP 293 815 discloses the heterogeneization of metallocene catalysts supported on the inorganic oxides by the chemical reaction between the functional alcoxysilane groups of the organometallic compounds and the surface hydroxyl groups of the inorganic oxides. The activity in the polymerization is not very high, probably as a consequence of the possible deactivation of the metallocene for the secondary products, which are formed during the reaction with the support.

40 The patent DE 3 840 772 A1 discloses the preparation of metallocene catalysts supported by reaction, between poly(methylhydrogensiloxane) and functionalized metallocenes with vinylic groups in the presence of a platinum catalyst. The process of synthesis and further anchorage of this kind of metallocene compounds are economically very expensive and the purity degree of the supported metallocene is not the desired one, resulting in very low polymerization activities.

45 The patents US 4 659 685, EP 318 048, US 50 302 562, EP 260 130 and EP 447 070 disclose the preparation of heterogeneous catalysts by directly supporting a non-metallocene compound of the metals of the groups 4, 5, or 6 of the periodic table on magnesium chloride, silica or aluminium phosphate, generally titanium halides, and a metallocene compound. The catalytic system is activated by the subsequent addition of aluminoxane or its mixtures with alkyl aluminium. The different polymerization rate of the titanium halides and of the metallocene compounds form multimodal 50 polyolefins, by preventing the obtainment of polymers with a narrow and controlled polydispersity.

55 The patent EP 474 391 A2 and the studies of K. Soga (Macromol. Chem. Rapid Commun. 12, 367 (1991)) and of S. Collins (Macromolecules 25, 1780 (1992)) disclose the preparation of heterogeneous metallocene catalysts by supporting them onto inorganic porous oxides, magnesium halides or their mixtures, previously treated with organoaluminium compounds. The thus obtained catalysts are used in the polymerization of olefins in gas phase or in suspension and are activated with organoaluminium compounds. The resulting activities are very low and the obtained copolymers do not show a random distribution of the comonomer, thus developing two melting peaks. On the other hand, the metallocene compound cannot remain perfectly anchored because a migration in the polymerization medium may occur, with the relative obtainment of small particles.

The patent EP 628 566 and K. Soga in a study published in *Makrom. Chem. Phys.* 195, 3347 (1994) disclose the direct synthesis of metallocene catalysts on an inorganic support. The method consists in the chemical reaction between alkaline cyclopentadienyl cations and the functional groups of the support, the subsequent reaction of the resulting solid with halides of transition metals of groups 4, 5, or 6, allows the formation "in situ" of the metallocene onto the support. The resulting activities in polymerization are very low; this is probably due to the by-products of the synthesis reaction whose separation from the catalyst is difficult.

On the other hand, there are no clear evidences of the fact that for this process it is possible to synthesize directly and in a good yield, the organometallic complexes onto the supports.

The patents US 5 057 475, EP 206 794 A1 and US 4 701 432 A1 disclose a method for the preparation of supported metallocene aluminoxane catalytic systems, by means of the simultaneous or subsequent addition of a metallocene compound and an aluminoxane onto an appropriate support. These catalysts can be used in polymerizations with or without additional co-catalyst. But for some kind of uses, the produced polymers have molecular weights and incorporation of co-monomer below the desired level. Moreover, the absence of appropriate interactions between the catalytic components and the support could cause the migration of the organometallic compounds during polymerization.

The patents US 4 939 217 and US 5 064 797 disclose the preparation of a supported aluminoxane by means of bubbling of a moistened inert gas in a solution of alkyl aluminium in the presence of the support. When a solution of metallocene is added, a heterogeneous catalytic system with good activities in the polymerization of olefins is obtained. But the thus obtained aluminoxane particles could not remain completely anchored onto the inorganic support because neither the morphology, nor the distribution and the size of the particle are the desired ones for this kind of uses. Consequently the apparent density and homogeneity of the polymer obtained by these heterogeneous catalysts is not the appropriate one. Moreover, for this method, the reproduction of the structure and of the molecular weight of the synthesized aluminoxane is very difficult, thus strongly jeopardizing the catalytic activity.

The patents EP 323 716, EP 361 866, EP 336 593, EP 367 503, EP 368 644 and US 5 057 475 disclose the preparation of supported catalysts by means of the "in situ" formation of aluminoxane onto silica by the reaction of aluminium alkyls with small quantities of water (6-50%) contained in the silica. Then, they impregnate the metallocene compound on the silica covered with aluminoxane. There are no data concerning the morphology and distribution of the particles sizes of the resulting polymer, but small particles of polymer are probably obtained since the metallocene is not strongly kept on the support, because it could migrate in the reaction medium.

The patent EP 314 797 discloses the preparation of catalytic systems supported by means of impregnation of the metallocene compound onto supports obtained by the precipitation of aluminoxane in an aliphatic solvent in which the aluminoxane is insoluble or by the co-precipitation with inert components such as polyethylene or inorganic solids totally or partially dehydroxylated. The thus formed catalyst is pre-polymerized by using organoaluminium compounds as co-catalysts. The polymerization activities are good but they do not supply data concerning the morphology and the distribution of the particle sizes.

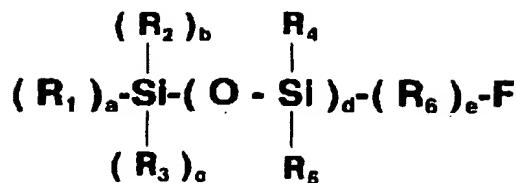
In the present invention a process for the obtainment of heterogeneous catalytic systems is described by using properly functionalized inorganic supports and metallocene catalysts. The use of these functionalized supports involves a strong anchorage between the catalytic support and the active species preventing their separation in the polymerization medium. The described method allows the obtainment of metallocene heterogeneous catalyst which properly control the morphology and the distribution of the particle sizes showing typical catalytic activities of the homogeneous catalysts.

#### DETAILED DESCRIPTION OF THE INVENTION

In the present invention heterogeneous catalytic systems resulting from the mixture of two components A and B are described, which are able to polymerize and co-polymerize  $\alpha$ -olefins, especially to homopolymerize ethylene and co-polymerize ethylene with  $\alpha$ -olefins. The catalytic activities are similar to those of the homogeneous catalysts. The polymers obtained with this kind of catalytic systems are characterized in that they have narrow distribution of molecular weights, show a good distribution of the particle sizes and they reproduce the morphology of the catalytic support. Moreover, these catalysts are particularly suitable in the incorporation of the co-monomer, by forming copolymers with completely random co-monomer distributions.

Thus it is an object of the present invention to provide a catalyst component (A) for the polymerization of  $\alpha$ -olefins in suspension, in gas phase at low and high pressures and temperatures or in a mass at high pressures and high or low temperatures, comprising:

a) a functionalized support (A.1) result from the reaction of an inorganic porous support constituted by one or more oxides of the elements of groups 2, 13 or 14 of the periodic table, dehydrated or not and a functionalizing compound of general formula:



(I)

10

wherein:

15  $\text{R}_1$  is halogen, aloxide of formula  $\text{OR}$ ,  $\text{R}$  being a branched or a linear alkyl having from 1 to 6 carbon atoms, a  $\text{C}_5\text{-}\text{C}_7$  cycloalkyl, a  $\text{C}_6\text{-}\text{C}_{10}$  aryl, a  $\text{C}_2\text{-}\text{C}_{10}$  alkenyl, a  $\text{C}_7\text{-}\text{C}_{10}$  arylalkyl or a  $\text{C}_7\text{-}\text{C}_{40}$  alkylaryl;

20  $\text{R}_2$ ,  $\text{R}_3$ ,  $\text{R}_4$  and  $\text{R}_5$ , equal to or different from each other, are linear or branched  $\text{C}_1\text{-}\text{C}_6$  alkyl,  $\text{C}_1\text{-}\text{C}_6$ ,  $\text{C}_5\text{-}\text{C}_7$  cycloalkyl,  $\text{C}_6\text{-}\text{C}_{10}$  aryl,  $\text{C}_2\text{-}\text{C}_{10}$  alkenyl,  $\text{C}_7\text{-}\text{C}_{10}$  arylalkyl, or a  $\text{C}_7\text{-}\text{C}_{40}$  alkylaryl.

$\text{R}_6$  is a methylene or propylene group;

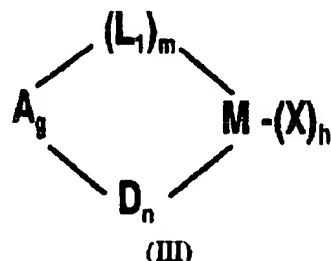
25  $\text{F}$  is selected from the group consisting of:  $-\text{NH}_2$ ,  $-\text{NHR}$ ,  $-\text{SH}$ ,  $-\text{OH}$ , or  $-\text{PHR}$  wherein  $\text{R}$  has the above defined meaning;

the addition of  $a+b+c$  is equal to 3,  $a$  being always higher than 0;

$d$ ,  $e$  can have independently values between 0 and 10;

b) an organo aluminium compound (A.2)

25 c) one or more metallocene complexes of groups 3, 4, 5 and 6 of the periodic table (A.3) represented by the general formula III:



35

wherein:

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$\text{M}$  is a transition metal of the groups 3, 4, 5 or 6 of the periodic table.

45 Each  $\text{X}$  is independently selected from the group consisting of hydrogen, halogen, linear or branched alkyl having from 1 to 10 carbon atoms,  $\text{C}_1\text{-}\text{C}_{10}$  alkoxy,  $\text{C}_5\text{-}\text{C}_7$  cycloalkyl,  $\text{C}_6\text{-}\text{C}_{10}$  aryl,  $\text{C}_6\text{-}\text{C}_{10}$  aryloxy,  $\text{C}_2\text{-}\text{C}_1$  alkenyl,  $\text{C}_7\text{-}\text{C}_{10}$  arylalkyl,  $\text{C}_7\text{-}\text{C}_{40}$  alkylaryl or  $\text{C}_8\text{-}\text{C}_{40}$  arylalkenyl.

45  $\text{L}_1$  is selected from the group consisting of: cyclopentadienyl ( $\text{Cp}$ ) of formula:

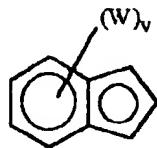


(h)

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indenyl ( $\text{Ind}$ ) of formula:

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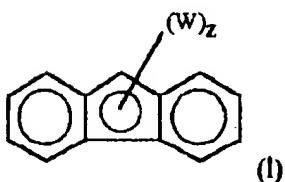


(i)

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fluorenyl (Flu) of formula:

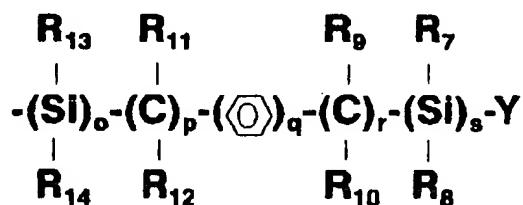
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wherein W is independently selected from the group consisting of hydrogen, linear or branched alkyl groups from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl, a group of general formula (IV):

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(IV)

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wherein:

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R<sub>7</sub>, R<sub>8</sub>, R<sub>9</sub>, R<sub>10</sub>, R<sub>11</sub>, R<sub>12</sub>, R<sub>13</sub> and R<sub>14</sub>, equal or different from each other, are hydrogen, linear or branched alkyl groups having from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl, which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl. R<sub>7</sub> and R<sub>8</sub> can also be equal to Y.

Y can be a halogen (i.e. F, Cl, Br I) or NR<sub>11</sub>R<sub>12</sub> or hydroxyl.

o, p, q, r, s are integers which can have values comprised between 0 and 10.

45

u = 5-g

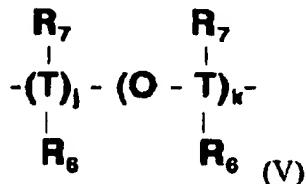
v = 7 -g

z = 9 -g

50

D has the meaning of L<sub>1</sub> or is an heteroatom belonging to 13, 14, 15, or 16 groups of the periodic table, A is a group which binds the ligands L<sub>1</sub> and D according to the formula (V):

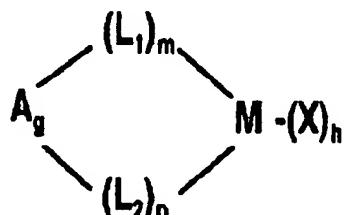
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wherein T is carbon, silicon, germanium or tin; j is an integer which can have the values of 0, 1, 2, 3 or 4; k is an integer which can have the values of 0, 1, 2 or 3; n, m and h are integers so as their addition is equal to 4; m and n have the values of 0, 1 or 2 so that their addition can be only 1 or 2; h can never be higher than 3; g is an integer comprised between 0 and 2; when h is equal to 3 then m + n are equal to 1 and g is 0.

Preferably the metallocene for the preparation of the supported catalyst A are represented by the following formula (IIIa):



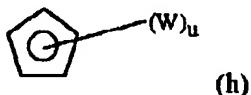
(III)a

wherein

M is a transition metal of the groups 3, 4, 5 or 6 of the periodic table.

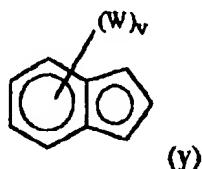
Each X is independently selected from the group consisting of hydrogen, halogen, linear or branched alkyls having from 1 to 10 carbon atoms, C<sub>1</sub>-C<sub>10</sub> alkoxy, C<sub>5</sub>-C<sub>7</sub> cycloalkyl, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>6</sub>-C<sub>10</sub> aryloxy, C<sub>2</sub>-C<sub>1</sub> alkenyl C<sub>7</sub>-C<sub>10</sub> arylalkyl, C<sub>7</sub>-C<sub>40</sub> alkylaryl or C<sub>8</sub>-C<sub>40</sub> arylalkenyl;

L<sub>1</sub>, L<sub>2</sub> are independently selected from the group consisting of: cyclopentadienyl (Cp) of formula:



(h)

indenyl (Ind) of formula:



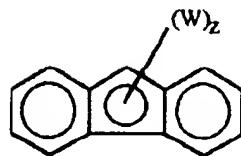
(y)

or fluorenyl (Flu) of formula:

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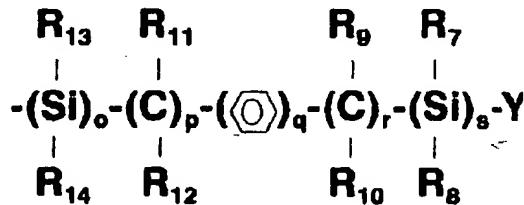


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(I)

wherein each W is independently selected from the group consisting of hydrogen, linear or branched alkyl group from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl, a group of general formula (IV):

20



25

(IV)

wherein:

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R<sub>7</sub>, R<sub>8</sub>, R<sub>9</sub>, R<sub>10</sub>, R<sub>11</sub>, R<sub>12</sub>, R<sub>13</sub> and R<sub>14</sub>, equal to or different from each other, are hydrogen, linear or branched alkyl groups having from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl, which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl. R<sub>7</sub> and R<sub>8</sub> can also be equal to Y.

35

Y can be a halogen (F, Cl, Br I) or NR<sub>11</sub>R<sub>12</sub> or hydroxyl

o, p, q, r, s are integers which can have values comprised between 0 and 10..

u = 5 - g

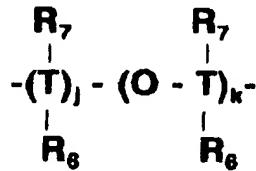
v = 7 - g

z = 9 - g

40

A is a group which binds the ligands L<sub>1</sub> and L<sub>2</sub> according to the formula (V):

45



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(V)

wherein

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T is carbon, silicon, germanium or tin; j is an integer which can have the values of 0, 1, 2, 3 or 4; k is an integer which can have the values of 0, 1, 2 or 3;

m and n are integers so as their addition is equal to 4; m and n have the values of 0, 1 or 2 so that their addition can be only 1 or 2; h can never be higher than 3; g is an integer comprised between 0 and 2;

when  $h$  is equal to 3 then  $m + n$  are equal to 1 and  $g$  is 0.

In the metallocene of formula (III) and (IIIa) M is preferably selected from the group consisting of Ti, Zr or Hf. This catalyst component can be used with a co-catalyst which is employed for the activation of the metallocene and it is 5 constituted by non-coordinative ionising compounds; preferably said co-catalyst is selected from the group consisting of methylaluminoxane or boron bulky compounds.

The used catalytic support can be an inorganic compound having a spherical morphology and with superficial hydroxy groups such as: oxides, silicates, carbonates phosphates, clay and their mixtures. Catalytic supports which 10 are preferably used are silica, alone or in combination with oxides of aluminium, titanium, vanadium, chromium, phosphorous, aluminium and phosphorous or their mixtures. The surface area of these supports can vary between 10-1000 m<sup>2</sup>/g preferably between 150-650 m<sup>2</sup>/g, the pore volume can vary preferably between 0.2-4 cm<sup>3</sup>/g preferably between 0.6-2.7 cm<sup>3</sup>/g and the average particle size can vary between 1-500 µm, preferably between 5-200 µm.

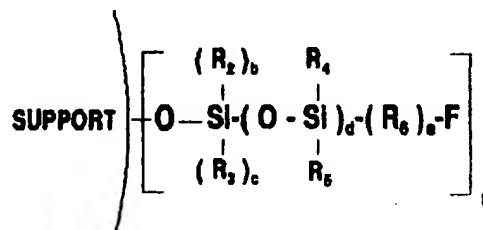
Generally these inorganic supports have different contents of water which can be removed or not. Supports are 15 preferably thermally treated in order to remove the water and reduce at will the concentration of the superficial hydroxy groups. Said treatment is carried out in a fluidized bed by heating the support in the presence of a dry inert gas, at temperatures comprised between 100 and 1000°C and preferably between 200 and 800°C. Once the drying process is completed, the support can be stored for a long time in the absence of air and humidity.

Once calcined the content of hydroxy groups on the surface of the support can be determined by means of a 20 volumetric evaluation of the separated ethane by treating a suspension of the support with a volume of a solution of triethylaluminium in a hydrocarbon solvent. The surface concentration of hydroxyl group depends on the calcination temperature and can vary between 0.1 and 4 meq OH/g of support, preferably between 0.3-3 meq OH/g of support.

The functionalization of the catalytic support is carried out by reaction between the surface hydroxy group of the 25 inorganic support and the reactive groups R<sub>1</sub>, of the compound of formula (I), in molar ratios OH/R<sub>1</sub> comprised between 0.10 and 6, preferably between 2 and 4. The reaction is carried out in aliphatic or aromatic hydrocarbon solvents (toluene, heptane, etc.), by keeping the temperature of the reaction medium between 25°C and 150°C, working preferably between 50 and 130°C and for 5-36 hours, preferably between 10-30 hours. The reaction by-products which are generally inert, can be easily removed by filtration and washing with hydrocarbon solvents. The resulting solids have the general formula (II):

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(II)

the functional groups will be more or less close to the surface of the support, depending on the value of  $d$  and  $e$ . The 45 value of  $f$  depends on the concentration of hydroxy groups on the surface of the support and on the molar ratios OH/R<sub>1</sub> used in the silanization reaction.

The supported catalysts of the present invention are prepared by adding the organo aluminium compound to a suspension formed by the functionalized catalytic support and the solvent. Afterwards, on the resulting solid, a solution 50 formed by one or more metallocene organometallic complexes of the elements of the groups 3, 4, 5 or 6 of the periodic table and a hydrocarbon solvent are added. It is desirable that the formed reaction byproducts be inert, volatile or easily extractable from the medium with the aim of avoiding that the catalytic system is contaminated; the catalytic activity could be jeopardized.

The quantity of the organoaluminium compound used can vary from 0.05 to 30 moles of Al/g of support, preferably 55 the concentration will be in the range from 1 to 15 mmoles Al/g of support. The reaction is carried out during 1-24 hours, preferably between 2 and 15 hours, in a temperature range comprised between 15 and 200°C, preferably between 20 and 150°C. The solids obtained by this process show aluminium contents comprised between 2 and 20%, preferably between 5 and 15%. The quantity of metallocene added to the functionalized support covered with organoaluminium can vary between 0.01 and 10 moles of metal/g of support, preferably between 0.1 and 7 moles of metal/g.

g of support. The reaction is carried out at temperatures comprised between 0 and 190°C, preferably between 20 and 130°C, during 1-20 hours, preferably between 2-15 hours. The content of the transition metal of the heterogeneous catalyst obtained depends on the content of aluminium of the support and can vary between 0.05 and 6%.

During the whole process both the chemical species and the solvents as well as the obtained products will be protected from oxygen and humidity. The heterogeneous catalyst will be stored in inert atmosphere, and will remain active in polymerization during long periods of time.

Further object of the present invention is a process for obtaining polyolefins characterized by the use of said catalytic system. The heterogeneous catalyst component (A), obtained according to the previous description, can be used in the polymerization or co-polymerization of  $\alpha$ -olefins by addition of the co-catalysts, component B. These co-catalysts are non-coordinative ionizing compounds such as alkyl aluminoxanes or bulky perfluoro boron compounds. Representative but not limitative examples are methylaluminoxane, dimethylalilinotetrakis (pentafluorophenyl) boron and trispentafluorophenylborane. If boron derivatives are used, it is advisable to add to the polymerization medium small quantities of alkylaluminium (TIBA, TEA, TMA, etc.).

The so prepared catalytic systems are suitable for the polymerization of  $\alpha$ -olefins having from 2 to 20 carbon atoms, particularly for the polymerization of ethylene, and for the co-polymerization of ethylene with one or more  $\alpha$ -olefins having from 3 to 20 carbon atoms, such as propylene, 1-butene, 4-methylpentene, 1-hexene, etc. with dienes and cycloalkenes. The polymerization can be carried out by polymerization processes in suspension, in gas phase or in mass at high pressures and temperatures. In suspension polymerization it is used as a reaction medium a hydrocarbon solvent such as linear or branched aliphatic hydrocarbons (hexane, heptane, isobutane, etc.), cyclic hydrocarbons (benzene, toluene, xylene, etc.) or a mixture thereof are used. The polymerization can be carried out between 1 and 2000 atmospheres and temperatures between 60 and 240°C, preferably between 40 and 180°C and the polymerization time can vary between 20 seconds and 6 hours depending on the process.

The used concentration of the supported metallocene catalyst (component A), referred to the transition metal (M), ranges from  $10^{-7}$  to  $10^{-3}$ , preferably from  $10^{-6}$  to  $10^{-4}$  moles of transition metal/l of solvent. The cocatalyst (component B) is used in a concentration from  $10^{-4}$  to  $10^{-1}$ , preferably from  $10^{-3}$  to  $10^{-2}$  moles/l of solvent. Higher concentrations of both components are also possible. When aluminoxanes are used as co-catalysts the used molar ratio Al/M ranges from 100 to 10.000, preferably between 500 and 1500. When boron compounds are used, the molar ratio B/M varies between 0.5-10, preferably between 0.9-5.

The preparation of the catalytic system for the polymerization of olefins can be carried out by mixing the components A and B in the polymerization reactor saturated with monomer or by mixing the components out of the reactor and adding the mixture to the reactor.

The molecular weight of the obtained polymer can be controlled varying the concentrations of the catalyst, of the co-catalyst and of the monomer in the polymerization medium, as well as the polymerization temperature with the addition of molecular weight regulators such as H<sub>2</sub>. When in the preparation of the catalyst a single metallocene compound is used, polymers with narrow distributions of molecular weights ranging between Mw/Mn = 2-4 are obtained. When two or more metallocene compounds are used, the obtained polymers have broader molecular weight distributions including multimodal distributions.

The co-polymerization reaction can be realized by using the same process as the one used in the processes of homopolymerization but feeding furthermore the reaction medium with the appropriate comonomer(s). The preferred molar ratios comonomer/monomer are comprised between 0.1 and 5. Copolymers are obtained with controlled contents of comonomer, random distribution and density ranging from 0.87 to 0.96 g/cc.

In order to better clarify the invention, some examples are described below. The materials, chemical compounds and conditions utilized in these examples are used in an illustrative way and not as a limitation of the claims of the invention. The average molecular weights by number, by weight and their distribution have been defined by GPC or SEC permeation gel chromatography. The thermal properties of the polymers have been defined by using differential scanning calorimetry. The intrinsic viscosities  $[\eta]$  have been obtained at 145°C by viscosimetric technique, the solvent used being trichlorobenzene with 0.05% antioxidant in order to avoid degradation. The determination of the particle sizes and of their distribution was carried out by laser technique. The morphology of said particles has been defined by optical and electronic microscopy.

## DESCRIPTION OF DRAWINGS

**Fig. 1** shows the distribution of the particles of catalyst C-1 compared with the distribution of the particles of the polymer of example 17 wherein the catalyst C-1 has been used.

**Photo 1** is an enlarged picture of polymer of example 17.

**Fig.2** shows the distribution of the particles of catalyst C-3 compared with the distribution of the particles of the polymer of example 18 wherein the catalyst C-3 has been used.

**Photo 2** is an enlarged picture of polymer of example 18.

## FUNCTIONALIZATION OF INORGANIC SUPPORTS

EXAMPLE 1- Support S-1

5        100 ml of dry toluene and 0.024 moles of 3-aminopropyltrimethoxysilane [(MeO)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>NH<sub>2</sub>] were added to 10 g of silica previously calcined at 300°C for a period of 4 hours having a specific surface area of 332 m<sup>2</sup>/g which contained 1.3 mmoles of OH/g of silica.

10      The reaction mixture was heated at 110°C and was kept for 12 hours at reflux. The resulting solid product was filtered and washed with different fractions of dry heptane (5 x 100 ml). The obtained white residue is dried at reduced pressure for 12 hours. The nitrogen content of the sample was 1.73%N.

EXAMPLE 2 - Support S-2

15      The same process as in example 1 has been carried out but 20 g of a calcined silica having the same surface area and containing 2.2 mmoles of OH/g of silica were used. 0.04 moles of 3-mercaptopropyltrimethoxysilane [(MeO)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>SH] were added. The sulfur content of the sample was 1.86% S.

EXAMPLE 3 - Support S-3

20      The same process as in example 1 has been carried out but 10 g of silica were used, whose specific surface area was 273 m<sup>2</sup>/g and contained 1.8 mmoles of OH/g of silica after calcination at 300°C during 4 hours. 6.8 mmoles of N-(phenyl)-3-aminopropyltrimethoxysilane [(MeO)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>CH<sub>2</sub>)<sub>3</sub>NHPh] were added. The nitrogen content of the sample was 0.65% N.

EXAMPLE 4 - Support S-4

25      The same process as in example 1 has been carried out but 4 g of silica were used whose specific surface area was 227 m<sup>2</sup>/g and contained 0.74 mmoles of OH/g of silica and after calcination at 800°C during 4 hours 12.2 mmoles of 3-aminopropyltrimethoxysilane [(MeO)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>NH<sub>2</sub>] and it was kept at 120°C for 24 hours were used. The nitrogen content of the sample was 1.15% N.

EXAMPLE 5 - Support S-5

30      17.24 g of calcined silica having specific surface area of 273 m<sup>2</sup>/g which contained 1.4 nunole OH/g of silica were put in an impregnation column. Further 250 ml of dry toluene were added and then 17.18 mmoles of 3-aminopropyltrimethoxysilane [(MeO)<sub>3</sub>Si(CH<sub>2</sub>)<sub>3</sub>NH<sub>2</sub>] dissolved in dry toluene were continuously fluxed into the column during 12 hours at room temperature. The resulting solid product was filtered and washed with different fraction of dry heptane (5 x 100 ml). The obtained white residue was dried at reduced pressure for 12 hours. The nitrogen content of the sample was 0.12% N.

PREPARATION OF THE CATALYSTEXAMPLE 6 - Catalyst C-1

40      120 mmoles of methylalumininoxane (MAO) in 80 ml of toluene were added to 11 g of functionalized support S-1. The reaction mixture was kept at room temperature under continuous mechanical stirring for 6 hours. The resulting solid was filtered and washed several times with toluene (5 x 100 ml). Afterwards the resulting solid was suspended in dry toluene and 3.4 moles of Cp<sub>2</sub>Zr Cl<sub>2</sub> were added. The reaction mixture was kept for 4 hours at room temperature under mechanical stirring. The solid in suspension was filtered and washed several times (5 X 100 ml) with dry toluene and then was dried for 12 hours under reduced pressure. The resulting solid catalyst contains 10.1% Al and 0.5% Zr.

EXAMPLE 7 - Catalyst C-2

45      10.2 mmoles of methylalumininoxane (MAO) in 80 ml of toluene were added to 3.2 g of the functionalized support S-4. The reaction mixture was kept at 40°C under continuous mechanical stirring for 2 hours. The resulting solid was filtered and washed several times with toluene (5 x 200 ml) and was dried under reduced pressure for 24 hours. Afterwards 2.9 g of the resulting solid w re suspended in dry tolu ne and 0.24 mmoles of rac-Et [ind]<sub>2</sub>Zr Cl<sub>2</sub> w re added. The reaction mixture was kept for 3 hours at 60°C under mechanical stirring. The solid in suspension was

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filtered and washed several times (5 x 200 ml) with dry toluene and then was dried for 24 hours under reduced pressure. The resulting solid catalyst contains 0.95% N, 4.8% Al and 0.25% Zr.

**EXAMPLE 8 - Catalyst C-3**

5        The same process as in example 6 was carried out but 5.5 g of support S-5, 37.5 mmoles of MAO and 1.7 mmoles of  $Cp_2ZrCl_2$  were used. The resulting solid catalyst contained 4.8% Al and 0.48% Zr.

**EXAMPLE 9 - Catalyst C-4**

10      The same process as in example 6 was carried out but 6 g of the support S-3, 15 mmoles of MAO and 1.7 mmoles of  $Cp_2ZrCl_2$  were used. The resulting solid catalyst contained 3.22% Al and 1.05% Zr.

**EXAMPLE 10 - Catalyst C-5**

15      51.7 mmoles of methylalumininoxane (MAO) in 80 ml of toluene were added to 9.2 g of aminopropyl-silica with a N content of 1.96% and a specific surface of 189  $m^2/g$ . The reaction mixture was kept at room temperature under continuous mechanical stirring for 2 hours. The resulting solid was filtered and washed several times with toluene (5 x 200 ml) and was dried under reduced pressure for 24 hours. Afterwards, 5.9 g of the resulting solid were suspended in dry toluene and 0.91 mmoles of  $Me_2Si-O-SiMe_2[Cp]_2ZrCl_2$  were added. The reaction mixture was kept at room temperature, under mechanical stirring for 3 hours. The solid in suspension was filtered and washed several times (5 x 200 ml) with dry toluene and then dried for 24 hours under reduced pressure. The resulting solid catalyst contains 1.32% N, 6.2% Al and 0.17% Zr.

25      **EXAMPLE 11 - Catalyst C-6**

30      30.5 mmoles of methylalumininoxane (MOA) in 20 ml of toluene were added to 0.335 g of  $rac-Et[Ind]_2ZrCl_2$ . Then 60 ml of toluene were added to the mixture. The reaction mixture was kept at 60°C under continuous magnetic stirring for 10 minutes. Afterwards, the resulting solution was added over a slurry of 6.25 g of support S-4 in 100 ml of toluene. The reaction mixture was kept at 60°C under continuous mechanical stirring for 4 hours. The resulting solid was filtered and washed several times with toluene (5x100 ml), and then was dried for 12 hours under reduced pressure. The resulting solid catalyst contains 7.14% Al, 0.37% Zr and 0.67% N.

**EXAMPLE 12 - Catalyst C-7**

35      The same process as in example 6 was carried out but 3.4 g of the support S-1, 21.3 mmoles of MAO and 4.1 mmoles of  $CISiMe_2CpCpZrCl_2$  were used. The resulting solid catalyst contained 1.32% Zr.

**POLYMERIZATIONS**

40      **EXAMPLE 13**

45      A 500 cc flask equipped with a magnetic stirring bar and with two necks sealed with a septum (one neck for the injection of the co-catalyst and the other one for the continuous feeding of ethylene) was dried and degassed with a nitrogen flux. In the flask 200 cc of dried and recently distilled toluene were injected. The flask was introduced in a water thermostated bath at 40°C. When the thermal balance was reached, the solvent was saturated with ethylene, under the pressure of 1.037 bars (1.023 atm), keeping the system under continuous stirring. 10 ml of a MAO solution in toluene (1.5 M on the total aluminium) were injected. After one minute 3 ml of a suspension of 1 g of the catalyst C-1 in 10 ml of toluene were injected. The system was fed with ethylene during 5 minutes. After this time the flux of ethylene was stopped and 20 ml of acidified methanol were injected. 3.72 g of polymer were obtained (2705 kg PE/mole Zr x h x atm). The essential characteristics of the obtained polyethylene were:  $[\eta] = 2.4 \text{ dl/g}$ ,  $M_n = 67561$ ,  $M_w = 241224$ ,  $M_w/M_n = 3.57$ ,  $T_m = 134^\circ\text{C}$ .

55      **EXAMPLE 14**

Ethylene was polymerized under the same conditions as in example 13 but the order of the addition of the co-catalyst and of the catalyst was changed. First of all 1 ml of a suspension of 1 g of catalyst C-1 in 10 ml of toluene was injected and immediately afterwards 3.25 ml of a solution of MAO in toluene (1.5 M on the total aluminium). 2.66 g of

polymer were obtained after 13 minutes of polymerization (2232 kg PE/mole Zr x h x atm). The essential characteristics of the obtained polyethylene were:  $[\eta] = 4.4$  dl/g, Mn = 170700, Mw = 550800, Mw/Mn = 3.2, Tm = 136.5°C.

#### EXAMPLE 15

5 Ethylene was polymerized under the same conditions as in example 13 but using the catalyst C-2. 5.8 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.726 g of the catalyst C-2 were injected. 1.4 g of polymer were obtained after 15 minutes of polymerization (271 kg PE/mole Zr x h x bar).

10 EXAMPLE 16

Ethylene was polymerized under the same conditions as in example 15 but using the catalyst C-5. 5.8 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.561 g of the catalyst C-5 were injected 3.6 g of polymer were obtained after 15 minutes of polymerization (664 kg PE/mole Zr x h x bar).

15 EXAMPLE 17

20 600 cc of n-heptane were added to a 1 l glass reactor previously dried and degased. The temperature was raised to 70°C and the solvent was stirred at 1200 rpm. When the thermal balance was achieved the medium was saturated with ethylene at 4 bar (3.95 atm of pressure). Afterwards the pressure has been reduced to 2 bars and 8.63 ml of a MAO solution in toluene were added (1.5 M on the total aluminium). The pressure was raised to 4 bars and then after 2 minutes 0.35 g of the catalyst C-1 were added. The system was fed with ethylene for 15 minutes and then the polymerization was stopped blocking the flux of ethylene and adding 20 ml of acidified methanol. 18.56 g of polymer were obtained (989 kg PE/mole Zr x h x bar). The essential characteristics of the obtained polyethylene were:  $[\eta] = 2.40$  dl/g, Mn = 94100, Mw = 251939, Mw/Mn = 2.67, Tm = 138°C. The maximum average diameter of the polymer particles is 22 times higher than the ones of the catalyst particles, showing a value of 1.77 mm, without particles smaller than 150 µm. The polymer is a good replica of the particle size distribution (fig.1) and of the morphology of the catalyst (photo 1), thus obtaining polymer particles with 76% of spherical factor.

30 EXAMPLE 18

35 Ethylene was polymerized as in example 17 but using the catalyst C-3,. 9.10 ml of a solution of MAO in toluene (1.5 M on the total aluminium) and 0.15 g of the catalyst C-3 were added. After 15 minutes of polymerization 27.30 g of polymer were obtained (3457 kg PE/mole Zr x h x bar). The essential characteristics of the obtained polyethylene were:  $[\eta] = 2.65$  dl/g, Mn = 86612, Mw = 270113, Mw/Mn = 3.1, Tm = 137°C. The maximum average diameter of the polymer particles is 30 times higher than the catalyst particles, having a value of 1.80 mm, only 4.1 % of the particles is smaller than 500 µm, without particles lower than 150 µm.

40 The polymer is a good replica of the particle size distribution (fig.2) and of the morphology of the catalyst (photo 2) thus obtaining polymer particles with 82% of spherical factor.

45 EXAMPLE 19

Ethylene was polymerized as in example 17 but using the catalyst C-4. 6.40 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.14 g of catalyst C-4 were added. After 15 minutes of polymerization 25.78 g of polymer were obtained (1632 kg PE/mole Zr x h x bar). The essential characteristics of the obtained polyethylene were:  $[\eta] = 1.9$  dl/g, Mn = 54904, Mw = 184969, Mw/Mn = 3.37, Tm = 135°C.

EXAMPLE 20

50 Ethylene and 1-hexene were copolymerized by using the same method as in example 19, with the difference that once the solvent was added and before the pressurization of the reactor, 39.42 ml of dried and recently distilled 1-hexene were injected. 10 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.18 g of catalyst C-4 were used. After 15 minutes of polymerization 97.55 g of polymer were obtained (4704 kg PE/mole Zr x h x bar). The main characteristics of the obtained polyethylene were :  $[\eta] = 0.7$  dl/g, Mn = 21400, Mw = 42827, Mw/Mn = 2.0, Tm = 114°C.

55 The determined content in 1-hexene by  $^{13}\text{C}$ -NMR was 2.32% by moles with a random distribution.

**EXAMPLE 21**

5 Ethylene was polymerized as in example 19 but with a starting hydrogen pressure of 0.5 bar. 6.87 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.16 g of C-4 catalyst were used. After 15 minutes of polymerization 18.0 g of polymer were obtained (1013 kg PE/mole Zr x h x bar). The main characteristics of the obtained polyethylene were: Mn = 5906, Mw = 10066, Mw/Mn = 1.7, Tm = 128°C.

**EXAMPLE 22**

10 Ethylene was polymerized as in example 17 but using catalyst C-5. 9 ml of a MAO solution in toluene (1.5 M on the total aluminium) and 0.47 g of catalyst C-5 were added. After 15 minutes of polymerization 8.2 g of polymer were obtained (959 kg PE/mole Zr x h x bar). The obtained polymer has a  $[\eta] = 2.0 \text{ dl/g}$ .

**EXAMPLE 23**

15 Ethylene was polymerized as in example 17 but using the catalyst C-6. 6.22 ml of a solution of MAO in toluene (1.5 M on total aluminium) and 0.16 g of the catalyst C-6 were added. After 15 minutes of polymerization 5.7 g of polymer were obtained (880 Kg PE/mole Zr x h x bar).

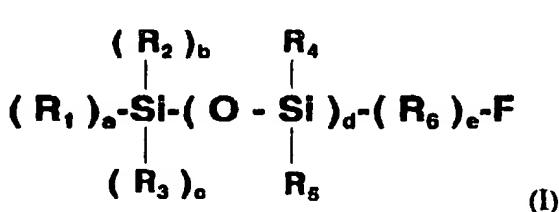
**EXAMPLE 24**

20 Ethylene and 1-hexene were copolymerized by using the same method as in example 20 but using the catalyst C-7. 10 ml of dried and recently distilled 1-hexene, 6.7 ml a solution of MAO in toluene (1.5 M on the total aluminium) and 0.069 g of the catalyst C-7 were added. After 15 minutes of polymerization 12.47 g of polymer were obtained (1250 kg PE/mole Zr x h x bar). The main characteristics of the obtained polyethylene were: Mn=44700, Mw=84100, Mw/Mn=1.88, the determined content in 1-hexene by  $^{13}\text{C-NMR}$  was 0.95% by moles with a random distribution.

**Claims**

30 1. Catalyst component (A) for the polymerization of  $\alpha$ -olefins in suspension, in gas phase at low and high pressures and temperatures or in a mass at high pressures and high or low temperatures, comprising:

35 a) a functionalized support (A.1) resulting from the reaction of an inorganic porous support comprising one or more oxides of the elements of groups 2, 13 or 14 of the periodic table, dehydrated or not and a functionalizing compound of general formula:



40 wherein:  
 R<sub>1</sub> is halogen, alcooxide of formula OR, R being a branched or a non-branched alkyl having from 1 to 6 carbon atoms, a C<sub>5</sub>-C<sub>7</sub> cycloalkyl, a C<sub>6</sub>-C<sub>10</sub> aryl, a C<sub>1</sub>-C<sub>10</sub> alkenyl, a C<sub>7</sub>-C<sub>10</sub> arylalkyl or a C<sub>7</sub>-C<sub>40</sub> alkylaryl;  
 R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub>, equal to or different from each others are linear or branched alkyl C<sub>1</sub>-C<sub>6</sub>, C<sub>5</sub>-C<sub>7</sub>cycloalkyl, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub>alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl, or a C<sub>7</sub>-C<sub>40</sub> alkylaryl.  
 R<sub>6</sub> is a methylene or propylene group;  
 F is selected from the group consisting of: -NH<sub>2</sub>, -NHR, -SH, -OH, or -PHR wherein R has the above defined meaning;

50 th addition of  $a+b+d$  is equal to 3, a being always higher than 0;  
 d, can have indipendently values between 0 and 10;

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b) an organo aluminium compound (A.2)  
 c) one or more metallocene complexes of groups 3, 4, 5 and 6 of the periodic table (A.3) represented by the general formula III:

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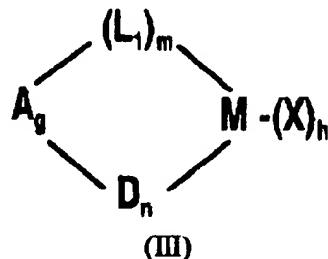
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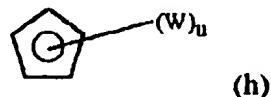
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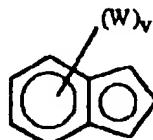


wherein:

M is a transition metal of the groups 3, 4, 5 or 6 of the periodic table;  
 each X is independently selected from the group consisting of hydrogen, halogen, linear or branched alkyl having from 1 to 10 carbon atoms, C<sub>1</sub>-C<sub>10</sub> alkoxy, C<sub>5</sub>-C<sub>7</sub> cycloalkyl, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>6</sub>-C<sub>10</sub> aryloxy, C<sub>2</sub>-C<sub>1</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl, C<sub>7</sub>-C<sub>40</sub> alkylaryl or C<sub>8</sub>-C<sub>40</sub> arylalkenyl.  
 L<sub>1</sub> is selected from the group consisting of: cyclopentadienyl (Cp) of formula:

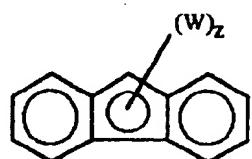


indenyl (Ind) of formula:



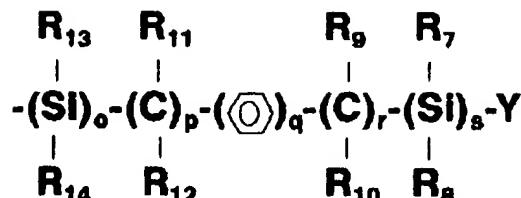
(i)

or fluorenyl (Flu) of formula:



(l)

wherein each W is independently selected from the group consisting of hydrogen, linear or branched alkyl groups from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl; a group of general formula (IV):



10 (IV)

wherein:

15  $\text{R}_7, \text{R}_8, \text{R}_9, \text{R}_{10}, \text{R}_{11}, \text{R}_{12}, \text{R}_{13}$  and  $\text{R}_{14}$ , equal or different from each other, are hydrogen, linear or branched alkyl groups having from 1 to 10 carbon atoms,  $\text{C}_5\text{-C}_7$  cycloalkyl, which can be substituted by an alkyl having from 1 to 6 carbon atoms,  $\text{C}_6\text{-C}_{10}$  aryl,  $\text{C}_2\text{-C}_{10}$  alkenyl,  $\text{C}_7\text{-C}_{10}$  arylalkyl or  $\text{C}_7\text{-C}_{40}$  arylalkyl.  $\text{R}_7$  and  $\text{R}_8$  can also be equal to  $\text{Y}$ .

20  $\text{Y}$  can be a halogen or  $\text{NR}_{11}\text{R}_{12}$  or hydroxyl

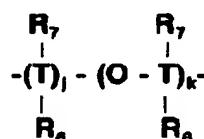
$\text{o}, \text{p}, \text{q}, \text{r}, \text{s}$  are integers which can have values comprised between 0 and 10.

$\text{u} = 5\text{-g}$

$\text{v} = 7\text{-g}$

$\text{z}=9\text{-g}$

25  $\text{D}$  is equal to  $\text{L}_1$  or is an heteroatom belonging to group 13, 14, 15, or 16 of the periodic table,  $\text{A}$  is a group which binds the ligands  $\text{L}_1$  and  $\text{D}$  according to the formula (V):



(V)

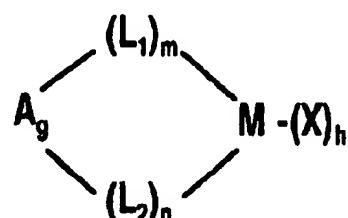
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wherein  $\text{T}$  is carbon, silicon, germanium or tin;  $j$  is an integer which can have the values of 0, 1, 2, 3 or 4;  $k$  is an integer which can have the values of 0, 1, 2 or 3;

40  $\text{m}, \text{n}$ , and  $\text{h}$  are integers so as their addition is equal to 4;  $\text{m}$  and  $\text{n}$  have the values of 0, 1 or 2 so that their addition can be only 1 or 2;  $\text{h}$  can never be higher than 3;  $\text{g}$  is an integer comprised between 0 and 2; when  $\text{h}$  is equal to 3 then  $\text{m} + \text{n}$  are equal to 1 and  $\text{g}$  is 0.

2. Catalyst component according to claim 1 characterized in that the metallocene for the preparation of the supported catalyst (component A) is represented by the following formula (IIIa):

45



55 (III)a

wherein

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M is a transition metal of the groups 3, 4, 5 or 6 of the periodic table.  
 each X is independently selected from the group consisting of hydrogen, halogen, linear or branched alkyls having from 1 to 10 carbon atoms, C<sub>1</sub>-C<sub>10</sub> alkoxy, C<sub>5</sub>-C<sub>7</sub> cycloalkyl, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>6</sub>-C<sub>10</sub> aryloxy, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl, C<sub>7</sub>-C<sub>40</sub> alkylaryl or C<sub>8</sub>-C<sub>40</sub> arylalkenyl;  
 5 L<sub>1</sub>,L<sub>2</sub> are independently selected from the group consisting of: cyclopentadienyl (Cp.) of formula:

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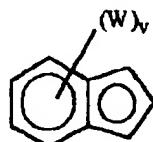


(h)

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indenyl (Ind) of formula:

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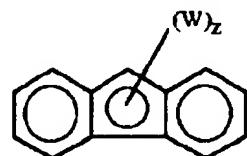
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(i)

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or fluorenyl (Flu) of formula:

35



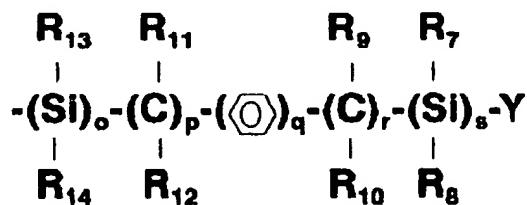
(l)

40

wherein each W is independently selected from the group consisting of hydrogen, linear or branched alkyl group from 1 to 10 carbon atoms, C<sub>5</sub>-C<sub>7</sub> cycloalkyl which can be substituted by an alkyl having from 1 to 6 carbon atoms, C<sub>6</sub>-C<sub>10</sub> aryl, C<sub>2</sub>-C<sub>10</sub> alkenyl, C<sub>7</sub>-C<sub>10</sub> arylalkyl or C<sub>7</sub>-C<sub>40</sub> alkylaryl, a compound of general formula (IV):

45

50



55

(IV)

wher in:

$R_7, R_8, R_9, R_{10}, R_{11}, R_{12}, R_{13}$  and  $R_{14}$ , equal to or different from each other, are hydrogen, linear or branched alkyl groups having from 1 to 10 carbon atoms,  $C_5-C_7$  cycloalkyl, which can be substituted by an alkyl having from 1 to 6 carbon atoms,  $C_6-C_{10}$  aryl,  $C_2-C_{10}$  alkenyl,  $C_7-C_{10}$  arylalkyl or  $C_7-C_{40}$  arylalkyl.  $R_7$  and  $R_8$  can also be equal to Y.

5 Y can be a halogen or hydroxyl

$\alpha, \beta, \gamma, \delta, \epsilon$  are integers which can have values comprised between 0 and 10.

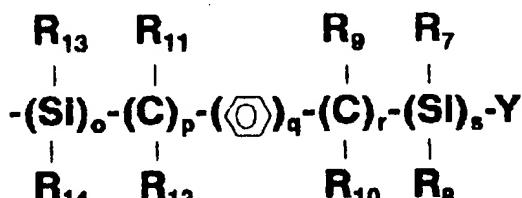
$u = 5-g$

$v = 7-g$

$z = 9-g$

10

A is a group which binds the ligands  $L_1$  and  $L_2$  according to the formula (V):



20

(V)

wherein T is carbon, silicon, germanium or tin;  $\beta$  is an integer which can have the values of 0, 1, 2, 3 or 4;  $\kappa$  is an integer which can have the values of 0, 1, 2 or 3;

$m$  and  $n$  are integers so as their addition is equal to 4;  $m$  and  $n$  have the values of 0, 1 or 2 so that their addition can be only 1 or 2;  $\kappa$  can never be higher than 3;  $g$  is an integer comprised between 0 and 2; when  $\kappa$  is equal to 3 then  $m + n$  are equal to 1 and  $g$  is 0.

30 3. Catalyst component according to claims 1 or 2 characterized in that the catalytic support is an inorganic compound with superficial hydroxy groups selected from the group consisting of: oxides, silicates, carbonates phosphates, clay and their mixtures.

35 4. Catalyst component according to claim 3 characterized in that the catalytic support is silica or silica in combination with oxides of aluminium, titanium, vanadium, chromium, phosphorous, aluminium and phosphorous or their mixtures

40 5. Catalyst component according to claims 1-2 characterized in that the surface area of the catalytic supports ranges from 10 to 1000  $m^2/g$  the pore volume varies between 0.2 and 4  $cm^3/g$  and the average particle size varies between 1 and 500  $\mu m$ .

45 6. Catalyst component according to claim 5 characterized in that the surface area of the catalytic supports ranges from 150 to 650  $m^2/g$  the pore volume varies between 0.6 and 4  $cm^3/g$  and the average particle size varies between 5 and 200  $\mu m$ .

7. Catalyst component according to claim 1 characterized in that the surface concentration of hydroxy groups on the inorganic support vary between 0.1 and 4 meq OH/g of support.

50 8. Catalyst component according to claim 7 characterized in that the surface concentration of hydroxy groups on the inorganic support vary between 0.3-3 meq OH/g of support

9. Catalyst component according to claims 1 characterized in that in the metallocene formula (III) M is selected from the group consisting of Ti, Zr, or Hf.

55 10. Catalyst component according to claims 2 characterized in that in the metallocene formula (IIIa) M is selected from the group consisting of Ti, Zr, or Hf.

11. Catalyst component according to claims 1-2 characterized in that in formula (IV) Y is selected from the group

consisting of Cl, Br or I.

12. Catalyst component according to claims 1-11, characterized in that the organo aluminium compound is an alkylaluminoxane having from 4 to 50 alkyl groups containing from 2 to 20 carbon atoms.

5

13. Catalyst component according to claims 1-12 characterized in that the ratio between the quantities of the porous inorganic support and the functionalizing agent of formula (I) are such that the molar ratio between hydroxy groups and R<sub>1</sub> groups of formula (I) ranges from 0.10 to 6.

10

14. Catalyst component according to claims 1-13 characterized in that the ratio between the quantities of the porous inorganic support and the functionalizing agent of formula (I) is such that the molar ratio between hydroxy groups and R<sub>1</sub> groups of formula (I) ranges from 0.2 to 4.

15

15. Catalyst component according to claims 1-10, characterized in that the ratio between the quantities of the functionalized supports of general formula (II) and of the organo aluminium compound described as A.2 is such that the ratio of Al per g of the functionalized support ranges from 0.05 to 30 mmoles/g.

20

16. Catalyst component according to claim 15, characterized in that the ratio between the quantities of the functionalized supports of general formula (II) and of the organo aluminium compound A.2 is such that the ratio of Al per g of the functionalized support ranges from 1 to 15 mmoles/g.

25

17. Catalyst component according to claims 1-16, characterized in that the ratio of the quantities of the functionalized supports of general formula (II) and of the organo metallic compound (A.3) is such that the ratio transition metal/g of the functionalized support ranges from 0.01 to 10 mmoles/g.

30

18. Catalyst component according to claims 1-17 characterized in that the ratio of the quantities of the functionalized supports of general formula (II) and of the organo metallic compound (A.3) is such that the ratio transition metal/g of the functionalized support ranges from 0.1 to 7 mmoles/g.

35

19. Catalytic system for polymerization of olefins according to claims 1-17 comprising the catalyst component of claim 1 and a co-catalyst constituted by non-coordinative ionizing compounds.

40

20. Catalytic system for polymerization of olefins according to claim 19 characterized in that the co-catalyst is selected from the group consisting of alkyl aluminoxanes, bulky boron compound or alkyl aluminium.

45

21. Process for obtaining polyolefins characterized by the use of the catalytic system according to claims 1-20.

50

22. Process for obtaining polyolefins according to claim 21 characterized in that the polymerization temperature ranges from -60°C to 280°C, the pressure ranges from 1 to 2000 atmospheres, the concentration of the transition metal ranges from 10<sup>-7</sup> to 10<sup>-3</sup> and the ratio co-catalyst B/transition metal is comprised between 10 and 10000 when using an organoaluminium compound and between 0.5 and 10 when using a boro compound.

55

23. A process for obtaining polyolefins according to claims 21-22 characterized in that the monomer is ethylene.

60

24. A process for obtaining copolymers according to claims 21-23 characterized in that the co-monomer is selected from the following group: 1-butene, 1-hexene, 1-octane, 1-hexadecane and 4-methylpentane or mixtures thereof.

25. Polyolefins according to claims 21-24 characterized in that the polymer does not contain particle having size lower than 100 µm..

FIG. 1

PARTICLE SIZE DISTRIBUTION

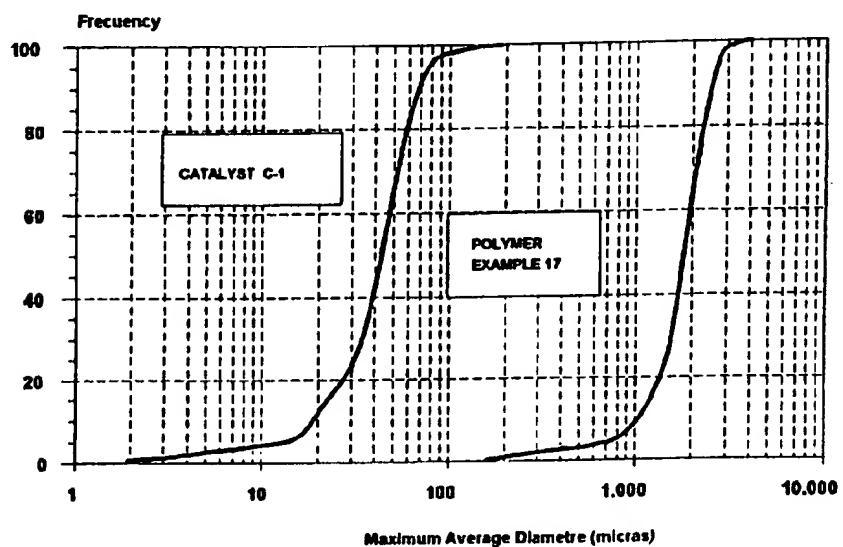
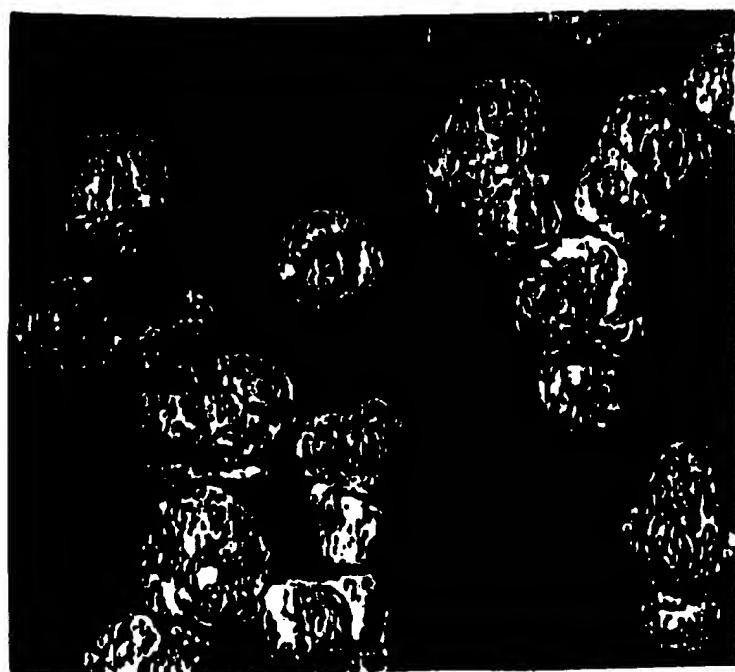
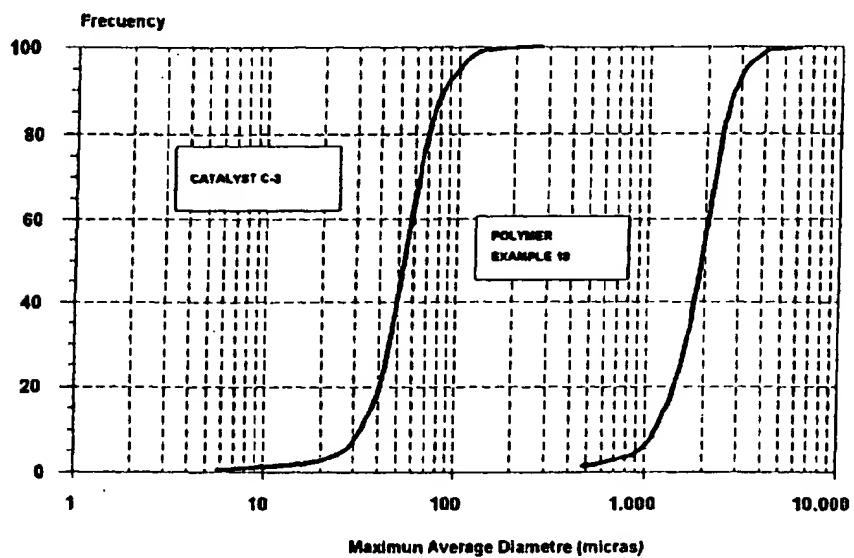


PHOTO 1

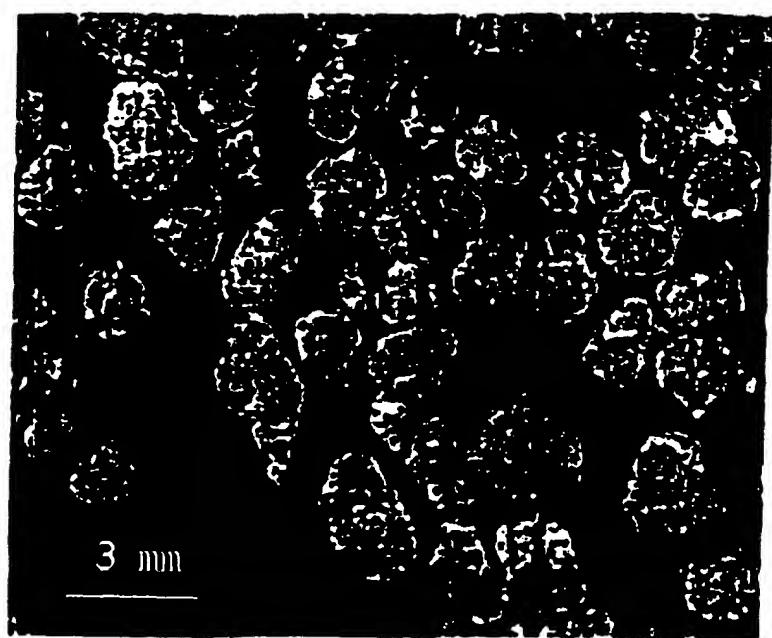


**FIG. 2**

**PARTICLE SIZE DISTRIBUTION**



**PHOTO. 2**





European Patent  
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## EUROPEAN SEARCH REPORT

Application Number  
EP 97 50 0068

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
P, X	EP 0 757 992 A (REPSOL QUIMICA SA) 12 February 1997 * the whole document * ---	1-25	C08F4/642
A	EP 0 670 336 A (BASF AG) * claims * ---	1-24	
A	EP 0 287 666 A (MITSUI PETROCHEMICAL IND) * claim 7; page 16, lines 11- 21 * ---	1-24	
A	MACROMOLECULAR SYMPOSIA, vol. 89, 1 January 1995, pages 249-258, XP000509171 SOGA K: "HIGHLY ISOSPECIFIC, IMMOBILIZED ZIRCONOCENE CATALYSTS SUPPORTED ON CHEMICALLY MODIFIED SI02" * the whole document; in particular page 250, lines 16-22 * -----	1-24	
TECHNICAL FIELDS SEARCHED (Int.Cl.6)			
C08F			
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	24 June 1997	Mergoni, M	
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